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A geographic assessment of the economic development impact of Korean high-speed rail stations

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ABSTRACT

As part of the balanced-development strategy, the Korean high-speed rail system—Korean Train eXpress (KTX)—is expected to serve not only as the next-generation intercity transit system, but also to have effects on regional development. With increased accessibility, HSR station locations have the potential to act as transport nodes as well as evolving as localized urban places by attracting higher-volume passenger flow and increasing economic activity. This paper evaluates the performance of KTX stations as an economic development strategy using the node-place concept, which simultaneously assesses a station's role as node and place. The calculated scores from the node-place index suggest various outcomes of KTX stations. While balanced stations are performing as both nodes and places and are located in urban centers, imbalanced stations that perform neither role well are found on urban peripheries. Our findings indicate imbalanced stations are less effective for attracting passengers and other economic activities. HSR station vitality is depends on interactions with existing urbanized areas, and those located in urban peripheries typically lack this. Station proximity to central business districts is an important consideration for locating future KTX stations in either mid-size cities or suburban areas, in order to maximize the economic impacts of KTX services.

1. Introduction

High-speed rail systems (HSR) are at the forefront of advanced transportation systems worldwide and are important not just for improved mobility but for their potential effects on regional development. The space-time compression produced by HSR networks can foster economic and social development throughout a country (e.g., in Japan, France, Spain, and China) at several spatial scales such as for a city, regiona, or even the area surrounding a station (Givoni, 2006; Jiao et al., 2017). Locating HSR stations has become an important strategy for decentralizing and improving urban and regional development (Kim, 2000; Priemus, 2008; Garmendia et al., 2012; Yin et al., 2015). For example, the National Planning Policy of South Korea established a balanced development strategy utilizing the KTX network and stations as points for new development with the hope that this will restructure the national urban system (Korea National Statistical Office, 2015). Similarly, the locations of new HSR stations in China has been considered as part of that country's urban and economic growth strategy, with medium-sized cities being specifically targeted (Yin et al., 2015). Planning efforts in both countries favor locating rail stations in suburban or peripheral areas to decentralize regional development.

HSR stations not only serve as a transportation node but by attracting a higher volume of passenger flows they may have the potential to serve as activity centers for shopping, dining, business meetings, and leisure (Peek and Louw, 2008), thus taking on the functions of an urban central place (Bertolini, 1999). For example, a number of firms and offices relocated near the Lille, France, HSR station because it played a role as a transportation hub serving a large volume of daily commuters and business trips (Ureña et al., 2009; Vickerman, 2015). With increased accessibility as a transport node and attractiveness as a business center, Lille also experienced residential population growth in the surrounding area (Ureña et al., 2009). Similar impacts have been identified around many HSR stations in Japan (Murayama, 1994; Murakami and Cervero, 2010). These examples suggest that planners can utilize the increased accessibility and attractiveness of high-speed services as a means to develop the regional economy (Wang et al., 2013).

Many successful HSR stations (e.g., Lille, Tokyo, Paris, Madrid, Beijing, and Seoul) are located either at or near their city centers where high

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demand for inter-city travel exists (Givoni, 2006; Vickerman, 2015). High-speed systems typically have fewer stops than traditional rail services to minimize the loss of travel time since each station is required to serve a larger population than stations for traditional rail lines. The effectiveness of HSR stations on economic development is mixed (e.g., Yin et al., 2015), with evidence suggesting stations located in suburban areas have lower ridership than expected and fewer expected economic outcomes. That said, locating HSR stations in either suburban areas or in smaller cities as part of a development strategy may pose uncertainty and financial risk, suggesting a great need for planners and policymakers to better understand the potential for development of different station locations (Moyano and Dobruszkes, 2017). This paper addresses these issues by examining the locations of various high-speed rail stations in South Korea's KTX system and their performance as transport hubs as well as urban places using the node-place concept. The intensity and diversity of transportation options through the network determine a station's role as a node, while its performance as a place is reflected by the economic activity surrounding the station.

2. Conceptual background

2.1. HSR infrastructure and development

Investment in transport infrastructure is considered an important catalyst for development (e.g., population and economic growth) and spatial integration either within or across countries (Aschauer, 1989; Bruinsma and Rietveld, 1993). Thus, investment in high-speed rail infrastructure has been perceived as a means for promoting regional development beyond the direct results of faster intercity travel (Vickerman, 1997; Campos and De Rus, 2009). Cities served by a high-speed network have increased accessibility and competitiveness (e.g., Martin, 1997; Vickerman, 1997; Jiao et al., 2014a,b; Shaw et al., 2014; Kim and Sultana, 2015), which can lead to employment growth and greater social inclusion (Givoni, 2006; Andersson et al., 2010; Chen and Haynes, 2015; Marti-Henneberg, 2015; Yin et al., 2015; Diao et al., 2016). For instance, improved accessibility by high-speed rail has contributed to European regional political and economic integration (Gutiérrez et al., 1996; Gutiérrez, 2001; Vickerman, 1997). Likewise, the integration of Chinese cities and provinces has been enhanced by the rapid expansion of the Chinese HSR network (Cao et al., 2013; Wang et al., 2013; Jiao et al., 2017).

Integrating HSR networks with other modes of transportation services is another recent strategy for regional development. HSR makes travel easier than other modes, such as airplanes, hence there is potential for a net increase in the number of passengers in the entire transportation market when the spatial interaction between places is increased. The growing market share of HSR creates constructive competition between other modes of transportation. Although HSR is in competition with air travel for trips between 400 and 600 km, high-speed trains have also been competitive with other ground transportation for long-distance intercity commuters (Vickerman, 1997; Levinson, 2012). Intercity bus services have been upgraded with lower fares, luxury buses, wi-fi connections, and seat power outlets to compete with high-speed trains. Likewise, air service has been improved with lower airfares and more connecting flights to compete with HSR (Albalate et al., 2015). Consequently, as competition between modes of transportation increases so does the quality of services for all modes of transportation. Additionally, HSR stations that are part of an integrated transportation network can serve as a feeder or supplement role to air transportation networks (Givoni and Banister, 2006). These competitive and cooperative networks reduce travel costs and generate more passenger for commuting, business travel, and leisure, which ultimately promotes economic development.

HSR also can contribute to accessibility inequalities between those cities served by both high-speed and conventional trains (Vickerman et al., 1999; Kim and Sultana, 2015). In Europe the high-speed network facilitated economic concentration in major cities, while negatively affecting economic activities in small and peripheral cities that were left off the network (Vickerman, 1997; Gutiérrez, 2001; Monzón et al., 2013; Chen and Haynes, 2015; Jia et al., 2017). Additional research suggests that intermediate cities on the HSR network have disadvantages in accessibility and have only limited success in attracting ridership compared to larger cities (Marti-Henneberg, 2015; Vickerman, 2015). In these cases, the absence of an HSR station has become an obstacle for balanced development despite the HSR's overall positive effects at the national scale (Moyano and Dobruszkes, 2017). The disparity of the benefits of HSR remains an ongoing issue where these networks have been constructed (Vickerman, 1997; Ureña et al., 2009; Garmendia et al., 2012; Kim and Sultana, 2015; Vickerman, 2015).

The spatial inequity from high-speed rail is unlikely to be mitigated without careful consideration of station locations and the utilization of surrounding space with integrated intra-regional transport connections (Ureña et al., 2009; Higgins and Kanaroglou, 2016). Traditionally railway stations attract businesses and other commercial and residential activities due to the relatively high accessibility these places offer. The remote location of some HSR services can be problematic for attracting development activities since HSR is designed for intercity travel and cannot provide 'door-to-door' service without the combination of other modes of transportation. Diao et al. (2016) investigated how the location of high-speed stations determines the quality of access to travelers, which is a crucial condition for attracting greater traffic flows and urban development. They pointed out that the integration of HSR stations and local transportation is required for any increase in intercity commuting by high-speed trains. Vickerman (2015) also noted that the new HSR stations in intermediate cities in Europe are mostly located in exurban areas (e.g., TGV-Haute Picardie, TGV-Lorraine) where transport options and urban development are very limited. Similarly, some HSR stations in Germany, South Korea, and Taiwan have lower ridership than expected, which is most likely due to the inappropriate location of these stations, resulting in a lack of development around the area (Marti-Henneberg, 2015; Yin et al., 2015). While not conclusive, these preliminary studies imply that the suburban HSR stations may have unfavorable conditions for generating traffic and hence attracting economic activities nearby.

2.2. The node-place model: a station area typology

Accessibility analysis is a common means for evaluating levels of locational benefits between cities after the introduction of high-speed trains in a country (Gutiérrez, 2001; Kim and Sultana, 2015; Jiao et al., 2017). Accessibility analysis, however, has limitations for examining activities such as land-use intensification and economic diversification around station areas. To fill this gap, the node-place model was developed (Bertolini, 1999) to evaluate the degree of performance for each station by focusing on the simultaneous roles of a station as a node on their transport network and as a place by the intensity of various economic activities resulting from the function of the node. In this model (Fig. 1), the node index measures the connectivity, accessibility, and service quality of a station (y-axis), and the place index measures the intensity and diversity of land uses resulting from various human activities around that station (x-axis).

The node-place model identifies five typical situations for a station area, labeled balance, dependence, stress, unbalanced node, and unbalanced place (Fig. 1). The "balanced" part in the middle area of the diagram indicates stations functioning as both 'nodes' and 'places'. In other words, in this scenario, both intensity and diversity of transportation and economic activities around the station area are functioning as expected. The highest performance of a station is identified as a "stress" situation, at the top right corner of the diagram, which indicates both a high supply of transportation and strong place function of a station operating at capacity. In this situation, development around the station area is already saturated and further development of the station area will require more land, which may cause conflicts around the station area. On the contrary,